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# Candidate Standard: Proposed Amendment No. 1 to ATSC Digital Television Standard, A/53 Part 4:2007 – MPEG-2 Video System Characteristics, Userdata

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The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

ATSC was formed in 1982 by the member organizations of the Joint Committee on InterSociety Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Television Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). Currently, there are approximately 140 members representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

ATSC Digital TV Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

### About the Candidate Standard

This specification is being put forth as a Candidate Standard by the TSG/S6 Specialist Group on Video and Audio Coding. ATSC members and non-members are encouraged to review and implement this specification and return comments to cs_amend_editor@atsc.org. ATSC Members can also send comments directly to the TSG/S6 Specialist Group. The ATSC believes this specification is stable. It is expected to progress to Proposed Standard within a period of time ending 20 September 2007.

# Candidate Standard: Proposed Amendment No. 1 to ATSC Digital Television Standard, A/53 Part 4:2007 – MPEG-2 Video System Characteristics, Userdata

## 1. PURPOSE OF THE AMENDMENT

The purpose of this amendment is to a) better enable the design of the carriage of cc_data() in other codecs; and b) make use of the definition of the cc_data() structure in CEA 708-C. This amendment is mostly a syntax restructuring and is syntactically compatible with A/53, Part 4:2007, except as follows. The first substantive change is the removal of the facility for the future use of additional_cc_data and additional_bar_data. These fields were empty and ATSC Reserved in A/53, Part 4:2007, and therefore any use today would have been a violation of A/53, Part 4. This amendment effectively proposes their use be forbidden. The reason for this is to remove any codec dependency from cc_data(). The removal from bar_data() is a side-effect of this removal. Any extension to the cc_data() and bar_data() structures would now require a new user_data_type_code value or user_data_identifier value. The second substantive change is the removal of the trailing marker_bits field in the bar_data() structure. The purpose of this is to align with work in SCTE and DVB. The marker_bits were not needed and since they are trailing, would be ignored even if present in legacy equipment.

Change instructions are given below in *italics*.

## 2. CHANGE INSTRUCTIONS

The following changes are specified by this amendment:

1) *Add reference* [19]:

   "SMPTE Registration Authority: http://www.smpte-ra.org/mpegreg/mpegreg.html".

2) *In Section 3.2, add the following new paragraph*:

   "**one_bits** – Each bit in fields marked, one_bits, shall be set to '1'".

3) *Sections 6.2 (lead-in), 6.2.1, 6.2.2, 6.2.3, and 6.2.4 shall be replaced with the text that follows*.

### 6.2 Bit Stream Specifications Beyond MPEG-2

This section covers the extension and user data part of the video syntax. The syntax used for the insertion of closed captioning[1], bar data and active format description in user data is described. "Picture user data" is used here to refer to user data inserted according to ISO/IEC 13818-2 [3], extension_and_userdata(2) structure placement as defined in ISO/IEC 13818-2, Section 6.2.2 [3], which follows the picture_header() and picture_coding_extension() structures.

#### 6.2.1 Picture Extension and User Data Syntax

The picture user data shall be constructed per ISO/IEC 13818-2, Section 6.2.2.2 [3]. Table 6.5 reproduces this syntax for the convenience of the reader, with the value 'i' replaced with the

[1] Implementers should note that CEA-708-C [1] describes the semantics for closed captions.

value '2' indicating the syntactic placement at the picture level (following picture_coding_extension().

**Table 6.5** Picture Extension and User Data Syntax (Informative)

| Value | No. of Bits | Format |
|---|---|---|
| extension_and_user_data(2) { | | |
| while ((nextbits() == extension_start_code ) \|\| (nextbits() == user_data_start_code)) { | | |
| if (nextbits() == extension_start_code) | | |
| **extension_data(2)** | | |
| if (nextbits() == user_data_start_code) | | |
| **user_data()** | | |
| } | | |
| } | | |

Note: In accordance with the bit stream syntax in Table 6.5, more than one picture user data construct may follow any given picture header.

No more than one user_data() structure using the same user_data_type_code (see Table 6.8 and Table 6.9) shall be present following any given picture header.

### 6.2.2 Picture User Data Syntax

Table 6.6 describes the picture user data syntax that shall be used for the user_data() structure carried in extension_and_user_data(2) of Section 6.2.2.2 of [3], reproduced for convenience in Table 6.5.

**Table 6.6** Picture User Data Syntax

| Syntax | No. of Bits | Format |
|---|---|---|
| user_data() { | | |
| **user_data_start_code** | 32 | bslbf |
| **user_data_identifier** | 32 | bslbf |
| user_structure() | | |
| } | | |

Receiving devices are expected to silently discard any unrecognized video user data encountered in the video bit stream. For example, if an unrecognized user_data_identifier is seen following the user_data_start_code, the user data should be discarded until another start code prefix is seen.

### 6.2.3 ATSC Picture User Data Semantics

**user_data_start_code** – This shall be set to 0x0000 01B2, which is the value is established for user data by ISO/IEC 13818-2 [3].

**user_data_identifier** – This is a 32 bit code that indicates the syntax and semantics of the user_structure() according to Table 6.7. It should be set to a registered value of the format_identifier as defined in ISO/IEC 13818-1 [2] and maintained by the SMPTE RA [19].

Note: Use of registered values, while not mandatory, is highly recommended as non-registered values can lead to errors in receiver processing of privately-supplied user_data() packets. The list of registered values is available at http://www.smpte-ra.org/mpegreg/mpegreg.html. Not all of these have application as user_data_identifier values in this context.

**user_structure()** – This is a variable length data structure defined by the value of user_data_identifier and shall be set according to Table 6.7.

**Table 6.7** user_data_identifier Value Assignments

| user_data_identifier value | user_structure() |
|---|---|
| 0x47413934 (“GA94”) | ATSC_user_data() (as defined in Table 6.8) |
| 0x44544731 (“DTG1”) | afd_data() (as defined in section 6.2.4) |
| All other values | Not defined in this Standard. |

**Table 6.8** ATSC_user_data Syntax

| Syntax | No. of Bits | Format |
|---|---|---|
| ATSC_user_data() { | | |
| **user_data_type_code** | 8 | uimsbf |
| user_data_type_structure() | | |
| } | | |

**user_data_type_code** – This is an 8-bit value that identifies the type of ATSC user data to follow in the user_data_type_structure() and shall be set according to Table 6.9.

**Table 6.9** user_data_type_code Value Assignments

| user_data_type_code value | user_data_type_structure() |
|---|---|
| 0x00 – 0x02 | ATSC Reserved |
| 0x03 | MPEG_cc_data() (as defined in Table 6.10) |
| 0x04 – 0x05 | ATSC Reserved |
| 0x06 | bar_data() (as defined in Section 6.2.3.2) |
| 0x07 – 0xFF | ATSC Reserved |

6.2.3.1 Captioning Data

Table 6.10 describes the syntax of captioning data.

**Table 6.10** Captioning Data Syntax

| Syntax | No. of Bits | Format |
|---|---|---|
| MPEG_cc_data() { | | |
| cc_data() | | |
| **marker_bits** | 8 | ‘1111 1111’ |
| } | | |

**cc_data()** shall be as defined in CEA-708-C [1], Table 2.

#### 6.2.3.2 Bar Data

Table 6.11 describes the syntax of bar data. Bar data should be included in video user data whenever the rectangular picture area containing useful information does not extend to the full height or width of the coded frame[2] and AFD alone is insufficient to describe the extent of the image. See Section 6.2.4.

When present, bar data shall be carried in the data structure bar_data(), within the picture user data syntax as shown in Table 6.6. After any sequence_header() such bar data shall appear before the next picture_data() within extension_and_user_data(2). After introduction, such bar data shall remain in effect until:

1) the next sequence_header(), or
2) extension_and_user_data(2) containing a bar_data() structure which contains new bar data, or
3) extension_and_user_data(2) containing AFD per Section 6.2.4.

After any sequence_header(), unless AFD data is present specifying otherwise, the absence of bar data shall indicate that the rectangular picture area containing useful information extends to the full height and width of the coded frame.

Bar data is constrained (below) to be signalled in pairs, either top and bottom bars or left and right bars, but not both pairs at once. Bars may be unequal in size. One bar of a pair may be zero width or height.

[2] In other words, the video is letterboxed (bars above and/or below video) or pillarboxed (bars left and/or right of video).

**Table 6.11** Bar Data Syntax

| Syntax | No. of Bits | Format |
|---|---|---|
| bar_data() { | | |
| **top_bar_flag** | 1 | bslbf |
| **bottom_bar_flag** | 1 | bslbf |
| **left_bar_flag** | 1 | bslbf |
| **right_bar_flag** | 1 | bslbf |
| **reserved** | 4 | '1111' |
| if (top_bar_flag == '1') { | | |
| **one_bits** | 2 | '11' |
| **line_number_end_of_top_bar** | 14 | uimsbf |
| } | | |
| if (bottom_bar_flag == '1') { | | |
| **one_bits** | 2 | '11' |
| **line_number_start_of_bottom_bar** | 14 | uimsbf |
| } | | |
| if (left_bar_flag == '1') { | | |
| **one_bits** | 2 | '11' |
| **pixel_number_end_of_left_bar** | 14 | uimsbf |
| } | | |
| if (right_bar_flag == '1') { | | |
| **one_bits** | 2 | '11' |
| **pixel_number_start_of_right_bar** | 14 | uimsbf |
| } | | |
| } | | |

Designation of line numbers for line_number_end_of_top_bar and line_number_start_of_bottom_bar is video format-dependent and shall conform to the applicable standard indicated in Table 6.12.

Note: The range of line numbers and pixels within the coded frame for each image format is specified in Table 2 of SMPTE 2016-1 [17].

**Table 6.12** Line Number Designation

| Video Format | Applicable Standard |
|---|---|
| 480 Interlaced 4:3 | SMPTE 125M [4] |
| 480 Interlaced 16:9 | SMPTE 267M [6] |
| 480 Progressive | SMPTE 293M [8] |
| 720 Progressive | SMPTE 296M [9] |
| 1080 Interlaced | SMPTE 274M [7] |
| 1080 Progressive | SMPTE 274M [7] |

**top_bar_flag** – This flag shall indicate, when set to '1', that the top bar data is present. If left_bar_flag is '1', this flag shall be set to '0'.

**bottom_bar_flag** – This flag shall indicate, when set to '1', that the bottom bar data is present. This flag shall have the same value as top_bar_flag.

**left_bar_flag** – This flag shall indicate, when set to '1', that the left bar data is present. If top_bar_flag is '1', this flag shall be set to '0'.

**right_bar_flag** – This flag shall indicate, when set to '1', that the right bar data is present. This flag shall have the same value as left_bar_flag.

**line_number_end_of_top_bar** – A 14-bit unsigned integer value representing the last line of a horizontal letterbox bar area at the top of the reconstructed frame. Designation of line numbers shall be as defined per each applicable standard in Table 6.12.

**line_number_start_of_bottom_bar** – A 14-bit unsigned integer value representing the first line of a horizontal letterbox bar area at the bottom of the reconstructed frame. Designation of line numbers shall be as defined per each applicable standard in Table 6.12.

**pixel_number_end_of_left_bar** – A 14-bit unsigned integer value representing the last horizontal luminance sample of a vertical pillarbox bar area at the left side of the reconstructed frame. Pixels shall be numbered from zero, starting with the leftmost pixel.

**pixel_number_start_of_right_bar** – A 14-bit unsigned integer value representing the first horizontal luminance sample of a vertical pillarbox bar area at the right side of the reconstructed frame. Pixels shall be numbered from zero, starting with the leftmost pixel.

#### 6.2.3.2.1 Recommended Receiver Response to Bar Data

Receiving device designers are strongly encouraged to study Consumer Electronics Association (CEA) bulletin CEB16 [16], which contains recommendations regarding the processing of bar data.

### 6.2.4 Active Format Description Data

Active Format Description (AFD) should be included in video user data whenever the rectangular picture area containing useful information does not extend to the full height or width of the coded frame. AFD data may also be included in user data when the rectangular picture area containing useful information extends to the full height and width of the coded frame.

When present, the AFD shall be carried using the syntax defined in [10], in extension_and_user_data(2) in the MPEG-2 video Elementary Stream. After any sequence_header() the default aspect ratio of the area of interest shall be that signaled by the parameters in the sequence_header() and sequence_display_extension() structures. After any sequence_header() the AFD, when present, shall appear before the next picture_data(). After introduction, such an AFD shall remain in effect until the next sequence_header() or until a new AFD is introduced.

> Note: The AFD syntax as shown in Section 6.2.4.1, when combined with the structures above to form the entire user data structure, is identical to that specified in ETSI TS 101 154 V1.7.1 [10], and is reprinted here with permission. Semantics are documented in Section 6.2.4.2; some are intentionally different from those in ETSI 101 154.

#### 6.2.4.1 AFD Syntax

Table 6.13 shows the syntax defined in [10] which is provided for the convenience of the reader.

**Table 6.13** Active Format Description Syntax

| Syntax | No. of Bits | Format |
|---|---|---|
| afd_data() { | | |
| **zero** | 1 | '0' |
| **active_format_flag** | 1 | bslbf |
| **reserved**[3] | 6 | '00 0001' |
| if (active_format_flag == '1') { | | |
| **reserved** | 4 | '1111' |
| **active_format** | 4 | bslbf |
| } | | |
| } | | |

6.2.4.2 AFD Semantics

**active_format_flag** – A 1 bit flag. A value of '1' indicates that an active format is described in this data structure.

**active_format** – A 4 bit field describing the "area of interest" in terms of its aspect ratio within the coded frame as defined in ISO/IEC 13818-2 [3].

The active_format is used by the decoder in conjunction with the "source aspect ratio." The source aspect ratio is derived from the "display aspect ratio" (DAR) signaled in the aspect_ratio_information, the horizontal_size, vertical_size, and display_horizontal_size and display_vertical_size if present (see ISO/IEC 13818-2 [3]):

- If sequence_display_extension() is not present, source aspect ratio = DAR
- If sequence_display_extension() is present, source aspect ratio = $\mathrm{DAR} \times \frac{\text{display\_horizontal\_size}}{\text{display\_vertical\_size}} \times \frac{\text{vertical\_size}}{\text{horizontal\_size}}$

The combination of source aspect ratio and active_format allows the decoder to identify whether the "area of interest" is the whole of the frame (e.g. source aspect ratio 16:9, active_format 16:9 center), a letterbox within the frame (e.g. source aspect ratio 4:3, active_format 16:9 center), or a "pillarbox" within the frame (e.g. source aspect ratio 16:9, active_format 4:3 center).

Table 6.14 defines the coding of the active_format field that shall be used.

[3] Note: The term and field, "reserved", is shown as published by ETSI and does not have the meaning of "reserved" as defined by ATSC.

**Table 6.14** Active Format

| active_format | Description | |
|---|---|---|
| | **4:3 coded frames** | **16:9 coded frames** |
| '0000' | undefined (see below) | undefined (see below) |
| '0001' | Reserved | Reserved |
| '0010' – '0011" | Not recommended | Not recommended |
| 0100 | Aspect ratio greater than 16:9 (see below) | Aspect ratio greater than 16:9 (see below) |
| '0101' – '0111' | Reserved | Reserved |
| '1000' | 4:3 full frame image | 16:9 full frame image |
| '1001' | 4:3 full frame image | 4:3 pillarbox image |
| '1010' | 16:9 letterbox image | 16:9 full frame image |
| '1011' | 14:9 letterbox image | 14:9 pillarbox image |
| '1100' | Reserved | Reserved |
| '1101' | 4:3 full frame image, alternative 14:9 center | 4:3 pillarbox image, alternative 14:9 center |
| '1110' | 16:9 letterbox image, alternative 14:9 center | 16:9 full frame image, alternative 14:9 center |
| '1111' | 16:9 letterbox image, alternative 4:3 center | 16:9 full frame image, alternative 4:3 center |

AFD '0000' indicates that information is not available and is undefined. Unless bar data is available, DTV receivers and video equipment should interpret the active image area as being the same as that of the coded frame.

AFD '0000', when accompanied by bar data, signals that the image's aspect ratio is narrower than 16:9, but is not either 4:3 or 14:9. The bar data should be used to determine the extent of the image.

AFD '0100', which should be accompanied by bar data, signals that the image's aspect ratio is wider than 16:9, as is typically the case with widescreen features. The bar data should be used to determine the height of the image.

Use of either '0010' or '0011' is not recommended in the ATSC television system. Values '0001', '0101' through '0111', and '1100' are reserved.

#### 6.2.4.3 Recommended Receiver Response to AFD

Receiving device designers are strongly encouraged to study Consumer Electronics Association (CEA) bulletin CEB16 [16], which contains recommendations regarding the processing of AFD.

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